2) The claims have been amended as follows.

Amended independent claim 16 incorporates features from prior claims 17 and 18 and a clarification of the terminology "n-type transparent semiconductor film" of the prior claim.

Claims 17 and 18 have been cancelled.

Claims 19 to 22 have been amended for conformance with the amended independent claim 16.

A Marked-Up Version of the amended claims is enclosed. The amendments are all supported by the substance and the context of the original disclosure, and no new matter has been added.

New claims 23 to 29 have been introduced. The new claims are supported by features of the prior claims and the original disclosure as shown in the following table, and do not introduce any new matter.

New Claims	23	24	25	26	27	28	29
Original Support	Cl.16	pg.17, ln.10-15	pg.17, ln.10-13	Fig.5; pg.14, ln.2-14	Fig. 5; pg.3,ln.32-pg.4,ln.5; pg.4,ln.11-14; pg.6,ln.24-26; pg.14,ln.2-14	Figs.1,2,8; pg.12,ln.3; pg. 17, ln.10-15	pg. 5, ln.3-20; pg.8,ln.32-pg.9,ln.11

Entry and consideration of the new claims and the claim amendments are respectfully requested.

3) Referring to section 1 on page 2 of the Office Action, the rejection of "claim 5" (actually directed to claims 16, 18 and 20 to 22) as indefinite under 35 U.S.C. §112, second paragraph is respectfully traversed.

The Examiner asserts that the term "n-type transparent conductor film" is an inappropriate term and is not supported by

the specification. These assertions are respectfully traversed. This film is exemplified by an IDIXO (In_2O_3 - 10 wt% ZnO) film, which is commonly known by persons of ordinary skill in the art to be an n-type semiconductor material. Also, the term "n-type transparent conductor film" is supported in original claim 2 and in the written description at page 5, lines 5 to 9; page 8, lines 32 to 33; page 16, lines 28 to 29; and page 22, line 6.

To make this term more precise and clear, it has now been amended to --n-type transparent **semiconductor** film--. Also, the feature of prior claim 18 has been incorporated into amended independent claim 16, so that this film is now particularly made of In_2O_3 - 10 wt% ZnO (IDIXO), which is generally known to be an n-type semiconductor.

For the above reasons, the Examiner is respectfully requested to withdraw the rejection for indefiniteness under 35 U.S.C. §112, second paragraph. Also, it becomes clear that the examination cannot be based on the assumption that this film is simply a "transparent conductor film", but rather that this film is an "n-type transparent semiconductor film" that is especially made of IDIXO.

4) Before particularly addressing the prior art rejections and comparing the prior art disclosures to the features of the claims, the invention will first be discussed in general terms to provide a background.

It is generally known in the prior art to provide an Au film on the surface of a light emitting device to act as a current injection layer or electrode. If the Au film is thin enough, it

is light transmissive. However, in order to achieve an adequate current injection and current spreading effect, an Au film by itself must have a thickness of about 20 nm (see the present specification at page 3, lines 8 to 10). With such a thickness, the Au film is actually only about 37% light transmissive at a wavelength of 500 nm. In other words, about 63% of the light is absorbed, which thus results in a substantial reduction of the light output of the light emitting device. On the other hand, if one would attempt to make the Au film thinner than 20 nm, then there would be insufficient spreading of the injected current, and as a result the light emission would be reduced.

As an alternative arrangement, it is also known in the prior art to provide a doped semiconductor layer at or near the surface of a light emitting device, as a current spreading layer. However, if one would attempt to provide an n-type transparent semiconductor film in contact with an underlying p-type semiconductor layer of the light-emitting device, then a p/n junction would necessarily be formed, thereby preventing an ohmic contact and inhibiting the proper current injection.

The present invention is based on the above background considerations. Basically, the invention aims to achieve "the best of both worlds" by using both an Au film and a doped semiconductor film in an upper electrode, while avoiding the disadvantages or problems of each of these two different upper electrode layers.

Namely, the invention aims to use an n-type transparent semiconductor film in the upper electrode arranged over a p-type semiconductor layer of the light emitting device, while avoiding

the formation of a p/n junction between these opposite conductivity type semiconductor materials. Simultaneously, the invention aims to use an Au film in the upper electrode while avoiding the reduction of light transmittance through the upper electrode and still achieving a good current injection and current spreading effect.

The invention, for the first time, has established and demonstrated that a very thin Au film can be provided between an n-type transparent semiconductor film of the upper electrode, and the underlying p-type semiconductor material of the light emitting device, to achieve the "best of both worlds" while avoiding the above discussed disadvantages. Namely, by providing the Au film with a thickness of 1 to 3 nm, this film is **thick enough** to avoid the formation of a p/n junction between the p-type semiconductor material of the light emitting device and the n-type semiconductor material of the upper electrode. Simultaneously, this Au film with a thickness of 1 to 3 nm is **thin enough** to avoid a significant reduction of light transmittance through the upper electrode.

Thus, the invention is based on a **balancing of competing or contradictory considerations**. Namely, the Au film should preferably be thicker in order to provide a good current spreading effect and to surely avoid the formation of a p/n junction, while the Au film should be made thinner to avoid or minimize the reduction of light transmittance through the upper electrode. The invention has established that an Au thin film with a thickness of 1 to 3 nm satisfies the competing considerations. Namely, this Au film is just barely thick enough to avoid the

formation of a p/n junction, yet is so thin that it does not significantly reduce the light transmittance through the upper electrode.

Also, in combination with the n-type transparent semiconductor film of IDIXO of the upper electrode, the Au film and the IDIXO film **together** provide a sufficient current spreading effect.

The inventive multi-layer upper electrode arrangement thus provides enhanced synergistic effects in comparison to either one of the component layers (either the Au film or the n-type transparent semiconductor film) considered by itself. This combination and interaction of features, as well as the synergistic improved results achieved thereby, would not have been suggested by or expected from the prior art.

5) Particularly according to independent claim 16, the invention is a semiconductor light-emitting device including a light-emitting layer, a p-type semiconductor layer on the light-emitting layer, and an upper electrode on the p-type semiconductor layer. The upper electrode includes an Au thin film and an n-type transparent semiconductor film. The Au film has a thickness of 1 nm to 3 nm and is positioned in contact with the p-type semiconductor layer. The n-type transparent semiconductor film is made of In_2O_3 - 10 wt% ZnO and is formed on the Au thin film. Thus, the Au thin film is interposed between the p-type semiconductor layer and the n-type transparent semiconductor film of IDIXO, so that the Au thin film disrupts or avoids the formation of a p/n junction therebetween. For this reason, the thickness of 1 to 3 nm

of the Au thin film is critical for attaining the synergistic combination according to the invention.

6) Referring to the bottom of page 2 to the top of page 4 of the Office Action, the rejection of claims 16, 18 to 20 and 22 as obvious over U. S. Patent 5,617,446 (Ishibashi et al.) in view of JP 06-318406 (Kazuyoshi et al.) is respectfully traversed.

The important features of present independent claim 16 are discussed above. Primarily, the invention is directed to the special structure of the upper electrode, which includes an Au thin film and an n-type transparent semiconductor film of In_2O_3 - 10 wt% ZnO (IDIXO). The Au thin film has a thickness of 1 nm to 3 nm, and is arranged in contact with the p-type semiconductor layer, and between the p-type semiconductor layer and the n-type transparent semiconductor IDIXO film.

Such a multilayered structure of an upper electrode would not have been suggested by the prior art.

7) Ishibashi et al. disclose an upper electrode structure for a light-emitting device that basically involves a p-type semiconductor contact layer (12) with a current spreading effect, arranged between an Au electrode film (14) and the underlying p-type semiconductor material (7 to 11) of the device.

There is no n-type semiconductor material in or adjacent to the upper electrode structure. Thus, there is no risk or issue of the formation of a p/n junction. Ishibashi et al. purposely use a p-type contact layer (12) on the underlying p-type semiconductor material (7 to 11) to achieve current spreading while

avoiding any formation of a p/n junction and achieving a good ohmic contact with the electrode (13) and the Au film (14) (see col. 2, lines 1 to 15; col. 5, lines 10 to 31; etc.).

Thus, Ishibashi et al. would not have provided any suggestion toward arranging an Au film **between** the p-type semiconductor material of the light emitting device and an n-type semiconductor layer of an upper electrode structure.

Also, Ishibashi et al. would not have provided any motivation toward the **particular thickness range** of an Au film that is suitable for preventing the formation of a p/n junction between such opposite-type semiconductor materials, as admitted by the Examiner (regarding prior claim 17).

In fact, Ishibashi et al. would not have provided any suggestions in the first place toward any sort of combination of an Au film and an n-type semiconductor film as transparent electrode layers of an upper electrode structure. Note that the electrode (13) is a grid-shaped electrode around the periphery of the device, and is formed of a thick metal such as Au or Pd/Pt/Au (col. 4, lines 15 to 18), while the Au film is applied in contact therewith as a transparent surface electrode layer for current injection. It thus appears that the only suggestions Ishibashi et al. would have provided relate to the "traditional" conventional use of an Au film as a transparent current injection layer or as a non-transparent grid electrode of an upper electrode structure.

The Examiner admits that Ishibashi et al. do not disclose (or suggest) a transparent thin film, and particularly an n-type

transparent semiconductor film formed on the Au thin film. For such a suggestion, the Examiner turns to Kazuyoshi et al.

8) The Examiner's proposed combination of the teachings of Ishibashi et al. and Kazuyoshi et al. is not motivated, suggested, or supported by the prior art.

The Examiner asserts that "*it would have been obvious ... to provide Kazuyoshi's transparent conductor layer on Ishibashi's Au thin film to seal the air and humidity from the Au layer*" (underlining added for emphasis). **The prior art references, however, provide no suggestion or motivation that it would be desirable or advantageous to "seal the air and humidity from the Au layer"**. This is a motivation proposed only by the Examiner, to support a hindsight reconstruction of the present inventive arrangement from disparate pieces of teachings of the prior art references.

As is generally known in the art, gold (Au) is highly resistant to oxidation and other deleterious effects that might be brought about by contact with air and moisture or humidity. Generally, a gold layer is purposely used as an outermost layer to provide resistance to air and humidity. Thus, there would have been no suggestion or motivation for a person of ordinary skill in the art, that any sort of covering layer should be provided over the Au film in order to "*seal the air and humidity from the Au layer*". No benefits would have been expected thereby. Thus, that proposed motivation is not a prior art motivation; but is merely a hindsight motivation proposed by the Examiner in order to construct the invention from separate prior

art teachings, by using the present application as a blueprint. Such a procedure of hindsight motivation or hindsight reconstruction of the invention is not a legally proper basis for an obviousness rejection.

Furthermore, neither Ishibashi et al. nor Kazuyoshi et al. provide any suggestion or motivation that it would have been advantageous or beneficial to arrange the transparent conductor layer according to Kazuyoshi et al. on the Au thin film according to Ishibashi et al. Based on the disclosure of Ishibashi et al, the person of ordinary skill in the art would have learned that it is completely acceptable to leave the Au film (14) exposed and uncovered as the uppermost layer of the electrode structure of the light emitting device. Ishibashi et al. and other understandings in the art do not provide any suggestion that the Au film (14) suffers any harm whatsoever from exposure to air and humidity. Therefore, a person of ordinary skill in the art would not have been motivated to seek to apply an additional layer over the Au layer as a seal against air and humidity.

Now considering Kazuyoshi et al., this reference also would not have provided any suggestions toward the combination of features as presently claimed, even when viewed together with Ishibashi et al. Kazuyoshi et al. provide a transparent conductor film containing indium (In) and zinc (Zn) as an upper electrode on a glass substrate. In other words, the transparent conductor film of Kazuyoshi et al. is not arranged on a p-type semiconductor material, so that there would be no issue or question of the possible formation of a p/n junction. Thus, there would have been no suggestion and no motivation to provide any

other layer, such as the present Au film, between the transparent conductor film and its underlying support layer. Also, Kazuyoshi et al. demonstrate that the transparent conductor film by itself achieves a good current conduction effect, so there would have been no motivation or reason to provide an additional Au film as a current injection or current spreading layer.

Further again considering Ishibashi et al. in this regard, it is expressly disclosed by Ishibashi et al. that the Au film (14) together with the p-type contact layer (12) provide a very good current injection and current spreading, so that there would have been no suggestion to provide an additional layer, and especially not an additional layer above the Au film, for somehow improving the current injection and current spreading. That effect (of the invention) only becomes significant when providing the Au film as a very thin layer, namely having a thickness of only 1 to 3 nm, which, by itself, would not provide an adequate current injection and spreading.

9) Since claim 16 now incorporates the feature of the thickness of the Au film (1 to 3 nm) from prior claim 17, and prior claim 17 had not been included in the present rejection, it is clear that the rejection cannot be maintained, already solely on these grounds.

10) For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claims 16, 18 to 20 and 22 as obvious over Ishibashi et al. in view of Kazuyoshi et al.

11) Referring to the bottom of page 4 of the Office Action, the rejection of claim 17 as obvious over Ishibashi et al. in view of Kazuyoshi et al., and further in view of U. S. Patent 6,255,003 (Woodard et al.) is respectfully traversed.

As mentioned above, the thickness limitation of the Au film from prior claim 17 has been incorporated into amended independent claim 16.

The Examiner admits that Ishibashi et al. do not disclose the thickness of the Au thin film. In this regard the Examiner turns to the teachings of Woodard et al.

However, the teachings of Woodard et al. relate to a different application and a different technology without any special teachings that pertain to the present upper electrode structure of a light-emitting device. A person of ordinary skill in the art would not have been motivated to use the teachings of Woodard et al. regarding the thickness of the Au film in the overall context of the light emitting device according to Ishibashi et al.

The present applicants do **not** contend that it was **completely unknown** to provide an Au film with a thickness of 1 to 3 nm in any context whatsoever. To the contrary, the present applicants concede that it is known as a general concept, that an Au thin film can be made to have a thickness of 1 to 3 nm, or even thinner. However, the combined teachings of the prior art would not have suggested to provide an Au thin film with a thickness of 1 to 3 nm **in the context of the present invention, or in the context of the Ishibashi et al. device**.

As explained in the background art discussion of the present application (see e.g. page 3, lines 7 to 10) it is conventionally known in the context of a light emitting device to use an Au film with a thickness of about 20 nm as a current diffusion electrode layer to achieve a sufficient current spreading effect in such a light emitting device.

On the other hand, Woodard et al. teach that heat reflective or electrically conductive layers on transparent sheets, such as window glazing sheets and the like, can use a gold layer with a thickness of about 0.6 to about 30 Å. These teachings say nothing about whether such a thin layer would have been effective as the Au film (14) in the light emitting device according to Ishibashi et al. To the contrary, the general understandings in the art (see e.g. the present application at page 3, lines 7 to 10) would have taught a person of ordinary skill that such a very thin Au layer would not have been effective as a current injection layer (14) in the structure of Ishibashi et al. Also, neither Woodard et al. nor any of the other references would have taught the ordinarily skilled artisan whether an Au film having a thickness of 1 to 3 nm would have been sufficiently thick to avoid the formation of a p/n junction in the inventive multi-layered arrangement.

The present invention, for the first time, has demonstrated that the combination of an Au film and an n-type transparent semiconductor IDIXO film as a combined upper electrode structure, allows the thickness of the Au film to be reduced to the range of 1 to 3 nm, while still achieving a sufficient current injection and current spreading effect for the combined upper elec-

trode structure. Neither Ishibashi et al. nor Woodard et al. provide any suggestions in this regard. Ishibashi et al. teaches nothing about the thickness, and Woodard et al. teach nothing about the appropriate thickness of a transparent current injection electrode layer on the upper surface of a light emitting device, especially for the combination of such an Au layer with a transparent IDIXO n-type semiconductor layer.

Thus, even if the teachings of all of these three references would have been considered in combination, there still would have been no prior art suggestion toward the appropriate thickness range of an Au film when that Au film is combined with an n-type semiconductor layer of IDIXO to form a composite or combined transparent upper electrode structure.

12) The rejections all appear to be based on a course of finding individual features of the invention in various individual references, and then holding the invention obvious based on a motivation that had not existed in the prior art.

Such a procedure is not a proper basis of an obviousness rejection. As a legal matter, an Examiner cannot "pick and choose" among various disparate features of various disparate references, while using the application being examined as a "blueprint" showing how the various pieces are to be combined to arrive at the claimed invention.

In the present rejection, the three prior art references, when considered together, would have provided no teachings and no suggestions whatsoever regarding the proper thickness range of the Au film to be used as a balance between the contradictory

considerations as discussed above (namely making the Au film **thick enough** to prevent the formation of a p/n junction, while making the Au film **thin enough** to avoid significantly reducing the light transmission). Also, the prior art references would not have provided any motivation for such a consideration, because the prior art references would not have suggested the arrangement of an Au film between a p-type semiconductor material and an n-type semiconductor film of the electrode structure, in the first place.

13) For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claim 17 as obvious over Ishibashi et al. in view of Kazuyoshi et al. and Woodard et al., as this rejection is not applicable against present independent claim 16 or any of the other present claims.

14) Referring to the top of page 5 of the Office Action, the rejection of claim 21 as obvious over Ishibashi et al. in view of Kazuyoshi et al. and further in view of U. S. Patent 4,495,514 (Lawrence et al.) is respectfully traversed. Claim 21 depends from claim 16 which has been discussed above in comparison to Ishibashi et al. and Kazuyoshi et al. The Examiner has further referred to Lawrence et al. for suggesting "*an electrode having a thin gold layer, which is a flattened layer, and an uneven upper transparent layer*". Even if such teachings of the reference would have been combined with Ishibashi et al. and Kazuyoshi et al., the features of present claim 21 would not have been suggested. Namely, claim 21 recites that the n-type transparent

semiconductor film has a multilayer structure including an upper layer with an uneven surface and a lower layer with a flattened surface. The gold layer is not a sub-layer or part of the n-type transparent semiconductor film. Thus, even a combination of the references would not have suggested the features of claim 21. For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claim 21 as obvious over Ishibashi et al. in view of Kazuyoshi et al. and Lawrence et al.

15) The new claims 23 to 29 recite additional features that further distinguish the invention over the prior art, for example as follows.

Claims 24 and 25 relate to an arrangement in which the Au thin film is discontinuous, e.g. in the manner of islands, to cover certain areas of the underlying p-type semiconductor layer, while leaving other areas thereof uncovered. This feature has not yet been addressed in the examination, and is not suggested by the prior art.

Claims 26 and 27 relate to the oxygen content of the n-type transparent semiconductor film, and how it influences the electrical resistance thereof. This feature has also not yet been addressed in the examination, and is not suggested by the prior art.

Claim 28 recites that the Au thin film and the n-type transparent semiconductor film are respective solid continuous films, and that the upper electrode structure does not include a grid-shaped electrode. This is directly contrary to the grid electrode (13) of Ishibashi et al.

Claim 29 expressly recites that the thickness of the Au film is sufficient to prevent the formation of a p/n junction that would otherwise be formed between the p-type semiconductor layer and the n-type transparent semiconductor film. The references are silent in this regard.

16) Favorable reconsideration and allowance of the application, including all present claims 16 and 19 to 29, are respectfully requested.

Respectfully submitted,

Takao NAKAMURA et al.
Applicant

By _____
Walter F. Fasse
Patent Attorney
Reg. No.: 36132
Tel. 207-862-4671
Fax. 207-862-4681
P. O. Box 726
Hampden, ME 04444-0726

WFF:ar/3905
Enclosures: Marked-Up Version of amended claims 16, 19, 20, 21, 22

CERTIFICATE OF FAX TRANSMISSION:

I hereby certify that this correspondence with all indicated enclosures is being transmitted by telefax to (703) 872-9318 on the date indicated below, and is addressed to: Assistant Commissioner for Patents, Washington, D. C. 20231.

_____ 11/12/02
Walter F. Fasse - November 12, 2002

By Fax TO: (703) 872-9318
Docket #3905
USSN: 09/519,408
A.U.: 2814; Conf. # 7245
Ex.: W. S. Louie

"Marked-Up Version"

16. [(new)] (amended) A semiconductor light-emitting device comprising:

a substrate having a back surface provided with an n-type lower electrode;

a light-emitting layer provided on said substrate;

a p-type semiconductor layer provided on said light-emitting layer; and

an upper electrode provided on said p-type semiconductor layer;

[wherein said p-type semiconductor layer is a semiconductor layer selected from the group consisting of a ZnSe-based semiconductor layer, a ZnTe-based semiconductor layer and a BeTe-based semiconductor layer; and]

wherein said upper electrode includes an Au thin film positioned in contact with said p-type semiconductor layer and an n-type transparent (semi)conductor film formed on said Au thin film[.]; and wherein said Au thin film has a thickness of 1nm to 3nm and said n-type transparent semiconductor film is made of In_2O_3-10wt% ZnO

19[.] [(new)] (amended) The semiconductor light-emitting device according to claim [18] (16, wherein said transparent (semi)conductor film of In_2O_3 – 10 wt.% ZnO is formed by laser ablation and has characteristics as result from being formed by laser ablation.

By fax to (703) 872-9318

3905

20. [(new)] (amended) The semiconductor light-emitting device according to claim 16, wherein said Au thin film [has a thickness] (is in a range) of 2 nm to 3 nm and said n-type transparent semiconductor film is [an] a layer of said In_2O_3 - 10 wt.% ZnO [layer] having a thickness of 180 nm to 200 nm.

21. [(new)] (amended) The semiconductor light-emitting device according to claim 16, wherein said n-type transparent semiconductor film has a multilayer structure including an upper layer and a lower layer, said lower layer having a flattened surface, and said upper layer having an uneven surface.

22. [(new)] (amended) The semiconductor light-emitting device according to claim 16, wherein said n-type transparent semiconductor film was deposited at room temperature and said device has characteristics as result from said n-type transparent semiconductor film having been deposited at room temperature.